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Broad Absorption Line Variability in Radio-Loud Quasars

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Abstract. We present preliminary results from an investigation into broad absorption line (BAL) variability within a sample of 41 radio-loud quasars (RLQs). Using 28 new Hobby-Eberly Telescope (HET) spectra along with earlier Sloan Digital Sky Survey (SDSS) or other archival data, we generate a total set of 50 pairs of BAL equivalent width measurements. Absorption variability in BAL RLQs typically consists of modest changes in the depth of trough segments, and variability is more common on longer rest-frame timescales; these tendencies are similar to previous findings for BAL radio-quiet quasars (RQQs). BAL variability in RLQs does not show any obvious dependence upon radio luminosity or loudness, but there is suggestive support for greater fractional variability within lobe-dominated RLQs.

We have conducted the first systematic survey of BAL variability within RLQs (Welling et al., in prep). BAL RLQs were identified through cross-matching SDSS BAL quasar catalogs (Trump et al. 2006; Gibson et al. 2009) to the FIRST radio survey. New HET targets were chosen to cover a wide range in radio and C IV BAL properties (note that the sample is predominantly composed of high-ionization BAL quasars). HET observations were carried out in 2007–2008 and 2011 in queue-scheduled mode. The Low-Resolution Spectrograph was used with the g2 grating and a 1.5″ slit, providing a spectral resolution of $R \simeq 870$ (sufficient for comparison to SDSS spectra). Data were reduced within *IRAF* following standard methods.

We find that C IV BAL variability in RLQs, where present, generally involves modest changes in the depth of trough segments. BAL variability was quantified using the absolute change and fractional change in equivalent width ($|\Delta EW|$ and $|\Delta EW/\langle EW\rangle|$). BAL RLQs tend to vary more on longer rest-frame timescales: there is a significant correlation between $|\Delta EW/\langle EW\rangle|$ and $\Delta\tau$, and the mean $|\Delta EW/\langle EW\rangle|$ is 0.17 ± 0.04 (0.07 ± 0.01) for $\Delta\tau > 500$ d (< 500 d). Similar tendencies have been established for BAL RQQs (Gibson et al. 2010; Capellupo et al. 2011). We construct a comparison sample of BAL RQQs from Barlow (1993), Lundgren et al. (2007), and Gibson et al. (2010). KS tests indicate that the distribution of BAL variability indicators (Figure 1, left) is not inconsistent ($p > 0.1$) between RLQs and a $\Delta\tau$-matched subset of RQQs (after filtering out objects with $\langle EW\rangle < 3.5$ Å). BAL variability in RLQs appears similar to that in RQQs, supportive of a common physical mechanism of BAL production.

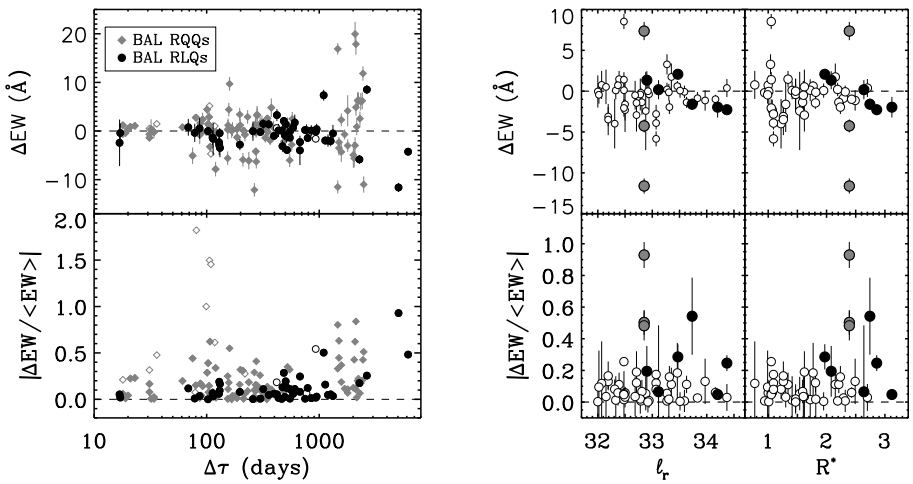

Figure 1. *Left*: BAL variability versus rest-frame timescale between observations for RQQs (gray diamonds) and RLQs (black circles). Open symbols have $EW < 3.5$Å. *Right*: BAL variability in RLQs versus radio luminosity and radio loudness for core-dominated (open) and lobe-dominated (filled) objects. The three long-timescale values for the lobe-dominated PG 1004+130 are plotted in gray.

Radio luminosity (ℓ_r) and radio loudness (R^*) do not appear to influence BAL variability strongly; neither $|\Delta EW|$ nor $|\Delta EW/\langle EW\rangle|$ are significantly correlated with either ℓ_r or R^*. Lobe-dominated RLQs may tend toward greater fractional variability (Figure 1, right); even omitting three long-timescale measurements for the lobe-dominated BAL RLQ PG 1004+130, the mean $|\Delta EW/\langle EW\rangle|$ is 0.23 ± 0.07 (0.07 ± 0.01) for lobe-dominated (core-dominated) RLQs. Due to the small number of lobe-dominated BAL RLQs in our sample and their generally greater $\Delta\tau$ and smaller $\langle EW\rangle$ values, further study is warranted. Nonetheless, these results may support some geometrical dependence to BAL structure in RLQs, as is also indicated by the generally steeper radio spectral indices of BAL RLQs recently found by DiPompeo et al. (2011).

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